

Electron Kinetics in Hypersonic Plasmas, Phase I

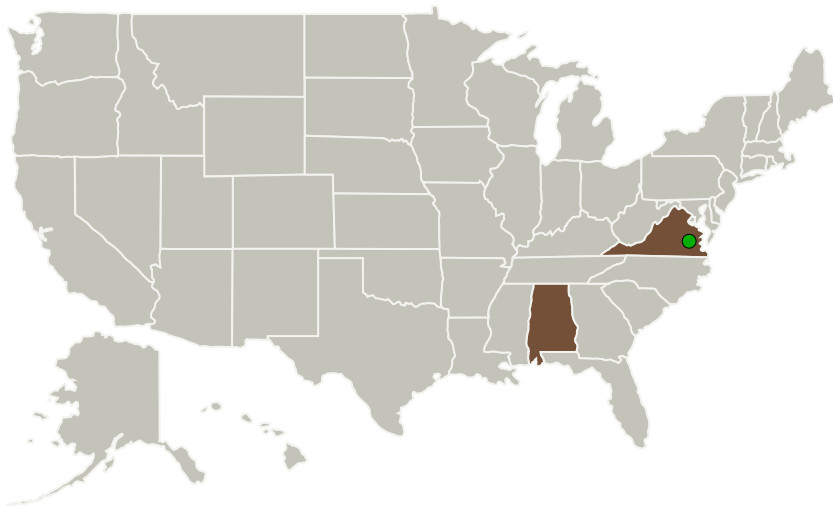
Completed Technology Project (2012 - 2012)



Project Introduction

The goal of this SBIR project is to advance the state-of-the-art in computations of hypersonic plasmas by adding high-fidelity kinetic models for electrons. Electron kinetics affects plasma-chemical reactions and nonequilibrium radiation, which are important for designing hypersonic vehicles. We will develop adaptive multi-scale models for electrons applicable for hypersonic flows in rarefied and continuum regimes using a hierarchy of kinetic and fluid solvers. During Phase 1, a framework for simulation electron kinetics will be added to our existing Unified Flow Solver. Initial testing will be performed to illustrate the feasibility of adaptive multi-scale simulations of electrons using three options: a) fluid model for high plasma densities, b) local Fokker-Planck solver for the Electron Energy Distribution Function, and c) spatially inhomogeneous (nonlocal) Fokker-Planck solver for rarefied flow regimes. In Phase 2, we plan to fully develop and validate the new models versus laboratory experiments. Increased predictive capabilities will be illustrated for the shock layer radiation in the poorly understood vacuum ultraviolet part of the spectrum. We will demonstrate the new tool for hypersonic vehicles with realistic 3D geometries. The effects of electric fields generated by the plasma and externally applied electric and magnetic fields will be taken into account to study discharges and MHD interactions. We will simulate the extreme entry environment at Earth and Mars entry.

Primary U.S. Work Locations and Key Partners



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Organizations Performing Work	Role	Type	Location
CFD Research Corporation	Lead Organization	Industry	Huntsville, Alabama
● Langley Research Center(LaRC)	Supporting Organization	NASA Center	Hampton, Virginia

Primary U.S. Work Locations	
Alabama	Virginia

Project Transitions

February 2012: Project Start

August 2012: Closed out

Closeout Documentation:

- Final Summary Chart(<https://techport.nasa.gov/file/138122>)

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

CFD Research Corporation

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

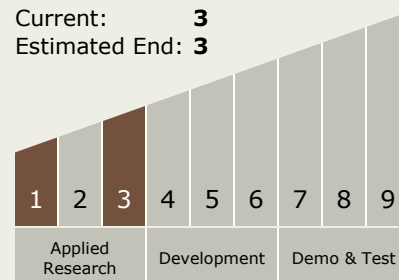
Carlos Torrez

Principal Investigator:

Vladimir Kolobov

Technology Maturity (TRL)

Start: **1**
Current: **3**
Estimated End: **3**



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Technology Areas

Primary:

- TX09 Entry, Descent, and Landing
 - └ TX09.4 Vehicle Systems
 - └ TX09.4.5 Modeling and Simulation for EDL

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System